Development of land-based Mobile Mapping System (MMS) using GPS and Close Range Photogrametry Technique

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Abstract

The last two decades have shown an increasing trend in use of GPS technology in several applications in Malaysia which including land vehicles and automated car navigation, GPS-equipped KLIA limousines, land and marine survey job which currently applied in private sector and DSMM (*Department of Survey and Mapping Malaysia*), deformation monitoring, etc.This research is concentrate on the geo-referencing the geographic and topography features and update a GIS (*Geographic Information System*) map using a consumer digital camera and GPS positioning technique. The GPS provided the position of the camera and the images from the camera are used to determine the positions of the objects.

1.0 Introduction

The last two decades have shown an increasing trend in use of GPS technology in several applications in Malaysia which including land vehicles and automated car navigation, GPS-equipped KLIA limousines, land and marine survey job which currently applied in private sector and DSMM (*Department of Survey and Mapping Malaysia*), deformation monitoring, etc.

The conventional method of mapping, such as aerial-photo interpretation and field surveys are coupled with the use of different remote sensing method, and all the data are integrated within a GIS environment. Limitations of traditional land-based surveying systems are the necessity to occupy each point of interest. The analysis of remote sensing data regards both optical and radar images. The processing of these conventional methods is more difficult, time consuming and cost higher. The use of digital camera is advantageous because they eliminate the requirement to scan photographs. Consequently they substantially reduce the period from raw data collection to extracted data dissemination.

The strength of the mobile mapping systems (*MMS*) lays in their ability to directly georeferenced their mapping sensor (*digital camera*) by GPS. A mapping sensor is georeferenced when its position and orientation relative to a mapping coordinate frame is known. Once georeferenced, the mapping sensor can be used to determine the positions of points external (*in digital photo*) to the platform in the same mapping coordinate frame. In the direct georeferencing done by MMS the GPS are used to determine the camera position and orientation. This is fundamentally different from traditional indirect georeferencing where the position and orientation of the platform are determined using measurements made to control points. These control points are established through a field survey prior to or after data acquisition, and their establishment is typically expensive and time-consuming. Therefore, eliminating this step results in obvious decrease in both the cost and time requirements for data collection. The task of establishing ground control is additionally complicated since its cost and time requirement are frequently difficult to estimate. Also, for many terrestrial surveys the establishment of sufficient ground control is virtually impossible- for example; consider the control requirements to map an entire city using close range photogrammetry. The establishments of these ground controls are not practical unless direct georeferencing is performed.

2.0 GPS and Close Range Photogrammetry

Global Positioning System (GPS) and Geographic Information System (GIS) field data collection is a perennial problem for cartographers, surveyors, engineers and researchers. Recently, the tools available for mapping applications have been bulky in size and weight, expensive, and difficult to learn. During the past year, tremendous advances have taken place in GPS technology (receivers), data collection hardware, and field data collection software. The autonomous GPS accuracy has been improved, the data collectors have become smaller, lighter, and less expensive. The GPS and GIS software has become cheaper and easier to learn. All of these advancements have made the GPS/GIS data collection tasks easier, faster and more economical.

Each GPS satellite transmits signals on two frequencies: L1 (1575.42 Mhz) and L2 (1227.60 Mhz). The L1 frequency contains the civilian Coarse Acquisition (C/A) Code as well as the military Precise (P) Code. The L2 frequency contains only P code. The P code is encrypted by the military- using a technique known as anti-spoofing and is only available to authorized personnel. The encrypted P code is referred to as the Y code. Civilian GPS receivers use the C/A code on the L1 frequency to compute positions, although high-end survey grade civilian receivers use the L1 and L2 frequencies' carrier waves directly. Military GPS receivers use the P (Y) Code on the both L1 and L2 frequencies to compute positions.

GPS receivers need at least three satellites for computation. Satellites position computation method is called triliteration. This position is accurate from about 10 to 15 meters. Now that selective availability, an intentional degradation of the satellites signals, has been turned off down to centimeters or less, depending on equipment and conditions.

It is important to understand that there are some amounts of uncertainties or errors, inherent in these positions. A number of factors contribute to this error including satellite clock drift, atmospheric conditions, measurement noise and multi-path. In addition, due to the satellite geometry, vertical accuracy (elevation) is generally one and a half to three times worse than horizontal accuracy.

For Close Range Photogrammetry, due to recent advances in micro-electronics and semiconductor technology, photogrametry in general has received a substantial push forward towards the fully digital domain. The development of new sensors, such as solid state camera, and more powerful computer hardware has opened new technologies and fields of application. Hybrid and fully digital acquisition and processing system have triggered much interest among photogrammetrist since the 15th International Congress of Photogrammetry and Remote Sensing in Rio de Janeiro in 1984. Within ten years, digital close range photogrammetry has matured to the extent that it can now serve as a precise and reliable technique for non contact three dimensional measurement. The ease and speed of data acquisition, the inherent on-line and even real time capabilities, the high degree of automation and the adaptability to varying the requests have made it a viable measurement tool for a great number of different applications in science, art and industry. (A.Gruen 1998)

3.0 Integration of GPS and Photogrammetry

Mobile mapping is essentially useless without the GPS component. The GPS component not only provides the location for all data collected but also provides the time in which it was collected. GPS also enable the user to navigate back to any particular location anytime thereafter. Once the field data has been collected using mobile mapping, the data can be downloaded into a desktop GIS. The GIS then provides the ability to analysis and processing.

Mobile Multi-sensor Mapping System is the system that integrated between an Inertial Navigation System (INS), GPS receiver and digital camera. The two navigation sensor-[GPS receiver and INS unit] provides georeferencing information (position and orientation) for the mapping sensor – [digital camera]. The system operation can be divided into three components: raw data acquisition, georeferencing of the digital images, and 3D feature extraction. Data acquisition begins by supplying power to the system while it is stationary. The IMU uses this time to “warm up”, while the GPS receiver uses this time to resolve integer ambiguities. After this warm up period, which lasts several minutes, it’s then free to capture images of points or objects of interest - ensuring that each point or feature of interest is captured in at least two images.

Once the data collection is completed, the images and navigation data from the INS and GPS sensor are downloaded to a personal computer. Then the INS and GPS data is processed and the digital images are georeferenced using particular software such as PhotoModeler. Finally, using photogrammetric principles and two or more georeferenced digital images, 2D and 3D positions of any point or object that is visible in two or more images can be determined.

The figure 1.0 below shows the integration between GPS and Photogrammery in mobile mapping.

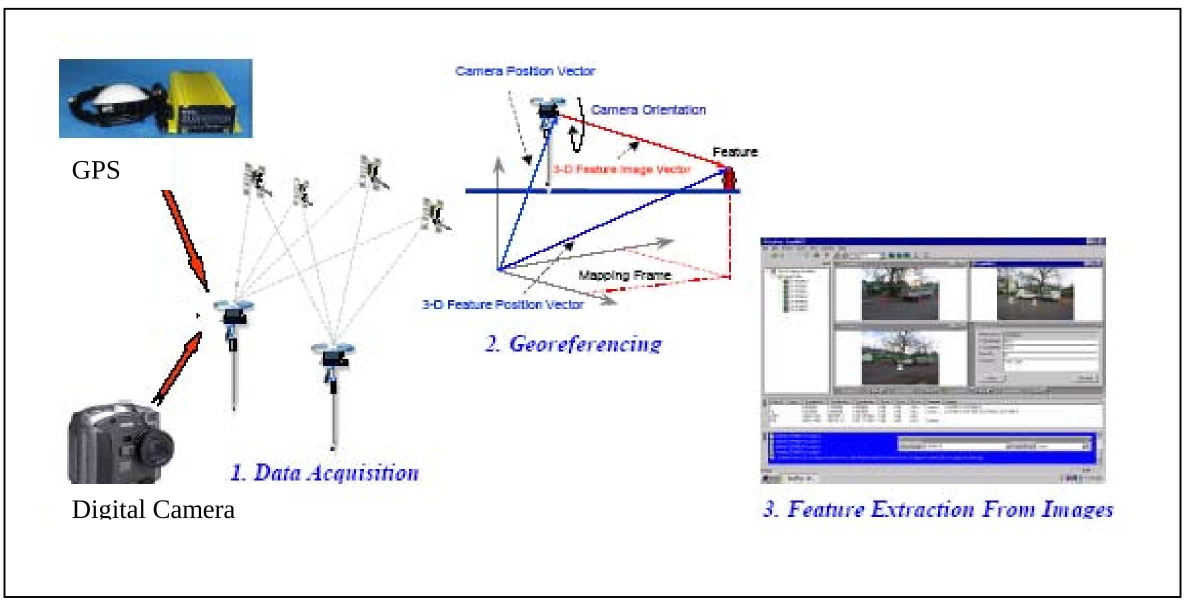

Figure 1.0 System Operation

4.0 Conclusion

In conclusion, the aim of this research is to evaluate the effectiveness of GPS and Photogrametry in development of land-based mobile mapping system in Malaysia. Geographical features of the digital image are georeferenced using Real Time Kinematic (*RTK*) GPS technique. The outcome of this research is hope to be useful and can be implemented in Malaysia. The MMS are deemed to be more comprehensive and innovative in the future.

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